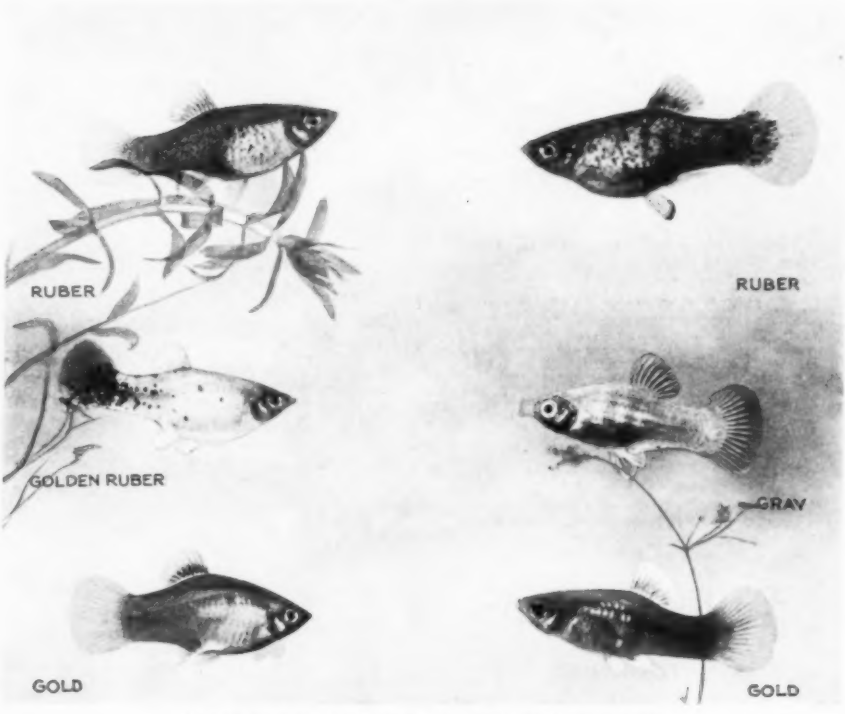
The Journal of HEREDITY



ANCESTRY OF THE GOLD PLATYFISH

(SEE PAGE 97)

Recent European Birth-Rate Trends

A Chicken-Turkey Hybrid

Early Maize Geneticists

Hereditary Disease Control in Germany

VOLUME 26 MARCH, 1935 NUMBER 3

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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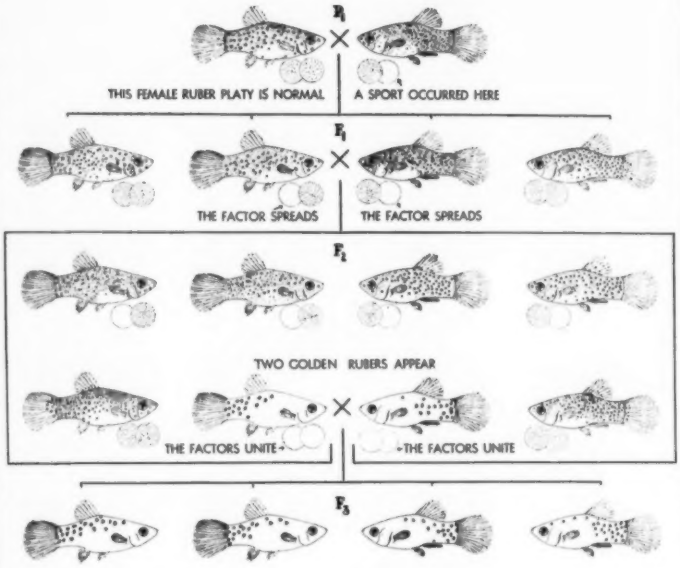
HOW THE PURE GOLD PLATYFISH WAS OBTAINED

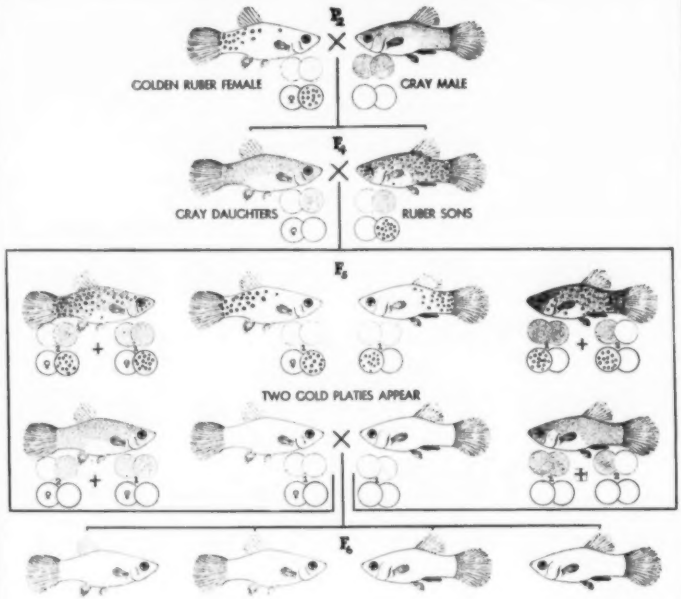
Frontispiece

I



The gold platyfish was derived from the ruber platy. The ruber platy is a composite of a gray, a red, a spotted, and a gold platy. The first break came when one of the ruber platies mutated (sported) to the gold and, as a result, one of its two hereditary factors for the gray color changed to a hereditary gold factor. This is indicated in the male (on the right) by one gray disc and one clear one. The female ruber is pure. This is indicated by two gray discs. These are the parents (P_1). The sporting father distributes the recently acquired gold hereditary factor to half of his offspring (F_1). When two offspring mate, each of which carries one inherited gold factor, some of the young inherit *two gold factors*. This combination decrees a golden color for twenty-five per cent of the second generation (F_2). When the golden rubers mate (note that they still have their black spots, and they are red, too) they produce a uniform brood like themselves shown under F_3 (the third generation).

II



If a female golden ruber be mated to a gray male (P_2), the old-fashioned ruber type is recreated in the male offspring (F_4). The female offspring inherit the gray from their father. The females *do not* inherit either spotting or red. When the newly recreated male ruber is mated to a gray female of the same brood, quite an array of platies appears, (F_5). The most interesting and desirable ones are the pure gold platies which appear once in eight offspring. By mating these gold platies together a brood of true breeding gold platies is established (as indicated under F_6). The gold platy appeared in 1920, and its origin has never been satisfactorily explained. The above charts outline the steps that probably were taken, more by accident than with any deliberate plan, to produce the new form. It is clear from these charts that the original gold platies were not the ones which actually went on a platy gold standard. This accomplishment must be credited to an ancestor six generations earlier.

DISCOVERY OF THE GOLD PLATYFISH

MYRON GORDON
Zoological Laboratory, Cornell University, Ithaca, N. Y.

ANY gold miner will tell you that when you are lucky enough to discover gold you do not usually find that noble metal in a pure state. Often the run-of-the-mine ore is pretty poor stuff, for gold in nature has many baser physical and chemical associates. Refiners through various technical processes isolate the pure metal, or combine gold with known quantities of other metals.

So with the gold platyfish. There are no *pure* gold platies in nature—in the *rios* and *arroyos* of southern Mexico. Yet in every platy in Mexico there is the making of a gold platy. I'll go further to say (and the chances of my being right are good) that if you have platies in your aquarium, no matter what their superficial colors may be, and you may have the red or ruber, the blue or gray platy, your platies are in part gold platies. They are masquerading. Most platies are gold platies, basically; the gold color of the masquerading platy is hidden by other pigment effects. Get rid of the reds and grays and black spots and you will have gold as a residue.

If, however, you have a white platy or an albino platy I'll admit that you do not have a gold platy, but you have something far rarer. You may refer to your true white platy, quite appropriately, as the *platinum* platy.

When I said, among other things, that the *ruber* platy is a gold platy plus a disguise, I meant that the ruber platy is a gold platy plus a red platy plus a black spotted platy plus a gray platy. In other words the ruber platy is a composite of four distinct color varieties, each of which may be, and has been, isolated, or, to use a technicological term in gold mining, refined. The metallurgist's technique of purification is by means of chemical and physical analyses. The fish fancier's technique is selection, appropriate mating and inbreeding.

If there are no *pure* gold platies in Mexico's streams, where did the first *pure* gold platy come from? From what strain of platy was it isolated? After it was obtained how was it multiplied to produce the pure race of true breeding gold platies?

Let us review, hastily, a few suggestions on some of these points in four American aquarium encyclopedias. They say that the first true gold platy appeared ready-made as a sport about fifteen years ago, in an aquarium of a German fish fancier. Upon this point there is inspiring accord, for witness these quotations:

Stoye—"The gold platy is a sport . . . a variation that occurs unexpected in nature."

Mann—"The gold platy is a sport . . . a freak of nature."

Uhlig—"The gold platy is a color mutation. . . . It just happened in the aquarium of a fancier who . . . appreciated it and 'fixed' it."

Peters—"A sport in nature is a sudden departure from the typical form or color. . . . The gold platy was such a sport. . . . Just what method was used in the propagation is not known."

As you see, they say that the gold platy is a sport but its genealogy is unknown. Let us not become discouraged. Let us be persistent and ask our questions again, and demand no cursory reply, for surely there must be more specific information on each count.

The First Gold Platy

The first question: where did the first gold platy appear?

Herr Otto Struve, a German fish fancier produced it first in a pure form and named it, exactly fifteen years ago. In his paper published in 1920 he promised to tell us how he developed the gold platy but, alas, nothing more was ever said. Herr Sachs tried to come to his rescue, two years later, and made

many suggestions relying upon some experimental work on permanent color changes in other animals, but, I am afraid, his ideas cannot be regarded as very plausible in the light of modern work in biology. While Herr Struve does not say how he got his gold platies, he drops a hint that turns out to be most significant. He says that a man had described a *golden* platy, lightly spotted with black, in the *Wochenschrift* in 1916 and again in 1918. This clue is too good to be passed up. The description of these is found to have been written by Herr Friedr. Kammerzell; here is a brief abstract of the salient points of his very illuminating notes:

"A brown platy female with black spotted sides" (*braun mit schwarzer Seitenzeichnung*) gave birth to some unusually marked and colored animals. The ground color of the new adult fishes is *yellowish red and they are marked with black spots.* When young, the new platies are pale yellow and fairly transparent; the black spots, which are to develop in a decided manner later, are barely visible. Since, to his knowledge, the female had been with no platy male, Kammerzell thought these unusual golden young were the product of hybridization with some other species. Later he gives up the idea.

The brown, black spotted female platy which Kammerzell describes as the mother of the yellow brood, is undoubtedly what we now know as the old-fashioned ruber platy, in which the males are brilliant red, but the females are dull red.

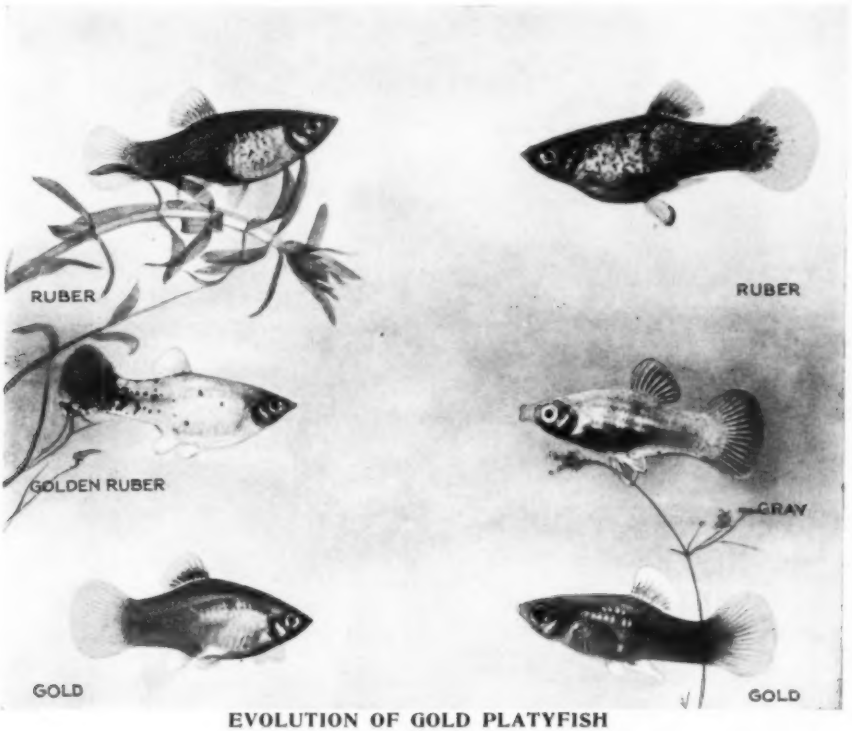
Kammerzell relates sadly his experiences with the golden, black-spotted platies. He lost his original brood of golden platies owing to the difficulties of getting fuel during the winter while the great war was going on. He was elated when another female, in 1918, produced a brood of *"twenty young among which I found five which showed that striking gold color."* Again these golden platies are black spotted. This ratio of *one* golden ruber to *three* normal rubers is the hereditary clue that will eventually solve the problem of the gold platy's origin. But no help in its solution comes from Herr Kammerzell directly. Herr Kammerzell whets our appetite for an explanation of these unusual platy goings-on by saying that he plans "to show how a normally colored parent may produce young which in part exhibit totally dissimilar colors." But, sad to relate, he, like Struve, fails to appear with the story.

Two important facts are gleaned from the reports of Kammerzell and Struve: the first *gold-like platy* appeared in the Kammerzell Brothers' aquaria not later than 1916. The first *true gold platy* was reported by Herr Struve in 1920. The Kammerzell gold platies were black spotted; Struve's platies were *not* spotted. Are these two phases of the gold platy (one spotted, the other non-spotted) related? If it can be shown that they are, then this and one other link in the hereditary chain, when properly arranged, should solve the problem of the origin of the pure gold platies. One link will join the old fashioned ruber platy to the golden rubers of Kammerzell. The second link will join the golden rubers to the pure gold platies of Struve.

The First Link: The Ruber to Golden Ruber

There seems to be no question about the fact that Kammerzell's golden ruber platies were derived from the old fashioned ruber, for even Kammerzell's 1918 paper is entitled: *"Ueber Gelbfarbung (Xanthorismus) bei Platypoecilus maculatus rote Varietat."* He says his *"rote Varietat"* is black spotted.

How was it possible for Kammerzell to have obtained five golden rubers in a brood of twenty? Some may suggest that these five golden rubers were sports. But sports rarely, if ever, occur in twenty-five per cent of the brood. They are probably the first visible result of a sport to the gold far back in their ruber platy family tree. It is as if we were witnessing a premiere performance of a play of the five gold-



EVOLUTION OF GOLD PLATYFISH

Figure 1

Above are the photographic representatives of platyfish shown in the charts (Frontispiece). The original parents (P_1) are ordinary ruber platyfish. In one of them a mutation to the gold occurred, but the effect of this mutation did not become visible until the golden rubers appeared in the second generation. In the second stage in the evolution of the gold platy, a third generation (F_3) golden ruber platy female is mated to a gray male. These two become the second important parental pair (P_2). A few pure, true breeding, gold platies appear in the fifth (F_5) generation. When inbred these reproduce all pure gold platies in the next and sixth (F_6) generation. The last brood of gold platies is six generations removed from the ruber (P_1) in which the first sport to the gold occurred.

en platies. We know that the golden platies must have existed before in rehearsal, but they were hidden from our view and we did not see them until the opening night.

Because there were *five* golden rubers to *fifteen* normal gray rubers in the show under Kammerzell's tent, the hereditary spotlight (the 3 to 1 ratio) focuses attention on one of the *grandparents* of these five golden rubers. These five golden rubers are merely the actors making their initial bow. The author of the play goes back two generations. The golden actors owe everything to their grandfather ruber who was given gold-developing qualities by a stroke of nature. Some call it sporting or mutating to the gold. Touched to gold by nature, this grandfather ruber platy was, nevertheless, unable to display its inheritance, for two gold elements are necessary before a platy can be gold colored.

This grandfather ruber platy passed on its potential gold-developing power to its offspring. Throughout the lifetime of these young, too, the display

of gold was withheld from public view, for while one half of the young rubers inherited one gold-developing element from their father, none of them had the two gold elements necessary for the complete development of a gold costume.

The premiere performance of the gold act, in the formal dress of gold, takes place when the second generation appears. One fourth of the young have managed to collect two golden hereditary elements and have stepped forward into the public gaze for the first time in glittering costumes of gold. Those satisfied with superficialities would bestow glory on the first five golden ruber actors, but those who know, give the credit to their creator, their grandfather ruber. Plain though he appeared, it was he who led his tribe along the golden path.

The origin of the golden rubers may be told in a more matter of fact way. *A sport to the gold occurred in a ruber platy, one of the grandparents of Kammerzell's golden ruber platies.* This mutation to the gold in the ruber platy affected one of the pair of hereditary color factors which governs the development of small black pigment cells that make the fish look gray. The effect of this mutation to the gold in the grandfather ruber platy was not revealed because the other and normal color factor of the gray-gold pair remained constant. The consequences of this mutation in the grandfather ruber affected the ruber's breeding performance but not its appearance. When mated to a normal ruber, the gold sport grandfather ruber spread the new hereditary color factor, gold, (lack of gray pigment cells) to many (just half) of its offspring, but at this point, his sons and daughters of the first generation were no different from the usual ruber in appearance.

When, by pure chance, two gold-carrying rubers of the first generation, each of which carries one gold factor, mate, there is opportunity for two gold factors (one from each parent) to combine and a gold offspring is born in the second generation. As a matter of chance, if two such gold-carrying rubers mate, there will be among their offspring, *one* gold platy to every *three* normal ones. This briefly sets up a hypothetical case which gives us results similar to those reported by Kammerzell.

The Second Link: Golden Ruber to Gold Platy

How can we get a pure gold platy of the Struve type from the golden rubers of Kammerzell? Wait for another sport? This is not necessary. Mate the golden, spotted ruber of the Kammerzell type to a gray platy. The gray platy has *no* large black spots and *no* red body color. If a golden ruber female is mated to a gray male as stated, normal-looking ruber males with spots and gray-looking females without spots appear. It looks as if the gold standard-bearers desert their colors. This is more apparent than real, for note what happens.

When the normal-looking gray daughters mate with their normal-looking ruber brothers, quite an array of variously colored platies appears. Each type of platy appears in a definite numerical ratio; among every three gray-like platies there is one gold-like platy; and for every golden ruber there is one pure gold platy.

The color types of platies line up in this manner:

Females	Males
3 ruber (gray and spotted)	3 ruber (gray and spotted)
1 golden ruber (spotted)	1 golden ruber (spotted)
3 gray	3 gray
1 pure gold	1 pure gold

By selecting the pure gold females and males and mating them, it is easy to get a pure breeding line of gold platies. This part of the story is not a description of a theoretical set-up; experiments similar to these have been performed time after time. No claim is made that Struve deliberately obtained his gold platies in the manner described. It is entirely possible that, by sheer chance, unbeknown to Struve, a series of matings such as outlined

above led to the establishment of the pure gold line.

Struve insists that his gold platies did not descend from ruber platies because *his gold platies throw only gold colored young.* This is not good reasoning. His gold platies breed true because the gold platy is a recessive in inheritance. It hides nothing; it cannot produce anything else when mated to its own type.

Here, then, are the questions asked and their answers:

Q. Where did the first pure gold platy appear?

A. It appeared in the aquarium of Herr Otto Struve not later than 1920.

Q. What were the ancestors of the pure gold platy?

A. The old fashioned ruber produced the Kammerzell golden ruber. The golden ruber, when mated to a gray platy, produced the pure gold platies in the second generation.

Q. How was the pure gold platy strain established?

A. It was established by inbreeding the gold platies.

Platies need not be considered aristocrats for adhering to the gold standard. Other species are similarly endowed with gold relatives. The swordtail, the medaka, and even the lowly guppy can all be "refined" to living gold.

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Twinning in Plants

SINCE twinning in plants has twice been reported in recent issues of the Journal,* it may not be out of place to call attention to the contrasts and resemblances between the physiological basis of twinning in animals and in plants. In animals only two fundamental types of twinning are recognized—twins arising from a single fertilized egg, and twins arising from two eggs separately fertilized. Twins arising from the double fertilization of a single egg may also occur.† It appears to me that in plants the possible processes in twinning might be as follows:

In plants only two instead of three of the macrospores might abort. This would account for twinning and here there are at least two possibilities, the one however, extremely remote. First, two pollen tubes from the same plant might reach the macrospores, in which case we would have "half identical" twins, as on the maternal side both cells arose from the common macrospore mother cell. Second, we might even assume that one pollen tube, or both, might have come from a plant of a different species, in which case we would have a hybrid. As remote as this pos-

*Waller, Adolph E., Iris Twins. *Journal of Heredity,* 25: 405, and A. P. Saunders, Peony Twins, *Journal of Heredity,* 26: 14.

†Castle, W. E., The Brahma-Plymouth Rock Mosaic. *Journal of Heredity,* 26: 66.

sibility is, yet it is worth considering as the situations set here could not possibly happen in animal reproduction, unless the polar cells were fertile, which seems unlikely.

It also appears that there might have been a complete fission after fertilization in which case we would have true identical twins, each embryo being like the other. This process parallels that in animal reproduction.

Either of the above processes must occur very rarely and yet I have found in not a few cases in peach seeds, two embryos, both vital and wholly unattached, not Siamese.

In the Maraposa grove of redwoods, there are two trees very close together, and of the same general size and age which are marked "twins." This is probably a misnomer as the chances are that they arose from two attached seeds.

EDWIN C. JACOBS.
Ashland College, Ohio.

First Statistics of German Sterilization

THE first session of a special eugenics court was held in Berlin on March 15 (1934). Up to May 30, twenty sessions had been held; in the meantime, a second chamber of the court has been organized. Within the period just mentioned, 348 court decisions were rendered, and in 325 cases sterilization of the person was ordered, while in the remaining twenty-three cases the request for sterilization was denied. In the 325 cases, the request came from the patients in 143 instances, seven times from the guardian, thirty-one times from the health officer, six times from the "court physician," and 138 times from directors of institutions. Table I shows the relative frequency of sterilization in males and females of various age groups.

TABLE I—Relative Frequency of Sterilization in Males and Females

Age Groups	Males	Females
Under 20 years	5	8
20-29 years	80	66
30-39 years	69	50
40-49 years	27	9
Above 50 years	11	0
	192	133

Table II shows the condition that was the basis for sterilization.

TABLE II—Basis for Sterilization

Hereditary Disorder	Number of Cases: Males	Females	Percentage of the Total
Congenital feeblemindedness	52	44	29.6
Schizophrenia	59	53	34.4
Circular insanity	6	3	2.8
Hereditary epilepsy	51	29	24.6
Hereditary chorea (Huntington)	1	0	0.3
Hereditary blindness	0	0	0.0
Hereditory deafness	1	1	0.6
Grave hereditary bodily deformity	0	3	0.9
Alcoholism	22	0	6.8
TOTALS	192	133	100.0

It appears that congenital feeblemindedness and schizophrenia each comprised about one third of the cases.

The eugenics court in Kiel ordered 102 sterilizations during the months of March and April. An analysis of the fifty-five sterilizations ordered in March, with respect to the basis justifying such intervention, is shown in Table III.

TABLE III—Analysis of Fifty-Five Sterilizations Ordered at Kiel in March 1934

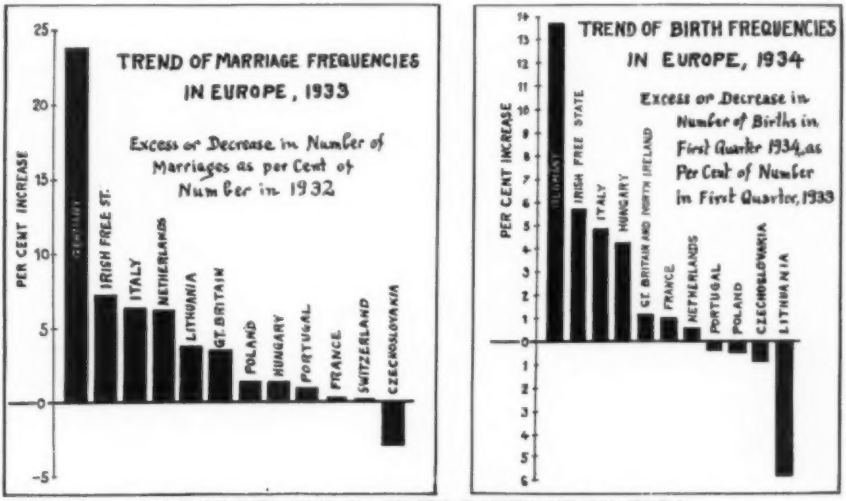
Hereditary Disorder	Males	Females
Congenital feeblemindedness	9	21
Schizophrenia	6	5
Epilepsy	4	6
Alcoholism	4	0

The Hamburg eugenics courts have received 1,325 applications for sterilization, a decision having been reached in 761 cases. Sterilization was refused in only seven cases. About 60 per cent of the cases concerned women.

Journal of the American Medical Association

THE RECENT RISE OF BIRTH RATES IN WESTERN EUROPE

FRANK LORIMER



IS THE DECLINE IN BIRTH RATES AT AN END?

Figure 2

For many years the trend toward fewer births among European peoples has been viewed as marking the "decline of the West." Recent European birth and marriage statistics suggest that some change may be taking place in this situation and that the down-fall of European civilization through a holiday in births may not be just ahead. The charts are modified from publications by Dr. Burgdörfer in *Wirtschaft und Statistik* and elsewhere.

PREDICTING population trends is probably less hazardous than forecasting weather conditions, but demographers have their troubles as well as meteorologists. One of the chief worries of the former at present is whether the accelerated decline in the birth rate in Europe and the United States during the years of economic disturbance marks a general "retreat from parenthood" that will continue indefinitely, or whether any signs of recovery or even adaptation to continued depression will bring about some rise in fertility or at least greatly slow up the trend toward population decrease.

Recent data from Europe give some evidence in favor of the latter alternative. The figures above are adapted from charts prepared by the German Statistical Offices. In the chart on the right, increases or decreases in births in the first quarter of 1934, compared with the first quarter of 1933, are shown for various European countries. Bars above the zero line show *increases* in the first months of 1934 above the corresponding numbers for the first months of 1933, for Germany, Irish Free State, Italy, Hungary, Great Britain, France, and the Netherlands—the amount of the increase being expressed in each case as a percentage of the number of births in the earlier period. In similar fashion *decreases* are shown by bars below the zero line for Lithuania, Czechoslovakia, Poland, and Portugal. It should be borne in mind,

of course, that the period with which the recent birth frequencies are compared was one of very low birth rates all over Europe. This comparison is based on numbers of births, but a comparison, over such a short period, using birth rates would yield results that differ by less than one per cent in most cases. On the other hand, small variations for short periods must always be used with caution. For example, if the comparison concerned the second quarters of the years 1933 and 1934, no increase would appear in the case of Italy, but the increase in the case of Germany would be greater.

Many First-Born

These increases in birth frequencies reflect, in large part, the rise in marriages during the preceding year, indicated by the diagram showing increases or decreases in marriages in 1933, compared with 1932. Thus Burgdörfer, using birth order data, has shown that the increase in births in Germany is due for the most part to an extraordinary increase in the number of first born children during 1934. Incidentally, we may note that 1934 is also proving to be a year of high marriage rates in Germany, so we may expect the higher birth rate in that country to persist for several years at least. These statistics do not necessarily indicate any trend toward larger families which, of course, would be essential for any sustained rise in birth rates. Nevertheless, they do indicate that depression birth rates are more or less abnormal, and that changed conditions are likely to bring about some reaction in their behavior.

Furthermore, these figures have other very interesting implications. The possible influence of national policy on population trends is strikingly demonstrated by the example of Germany. It is especially interesting in this connection to note that the change has been most rapid in the urban population. Thus the birth rate for all large cities jumped from 11.0 per 1,000 persons in June, 1933 to 14.9 per 1,000 persons in June, 1934, an increase of 35 per cent in one year (using rates computed on a yearly basis).

French Population Stable

Again, the very moderate increases indicated for France and the Netherlands, taken in their full context, are highly significant, merely as showing the maintenance of the relatively high rates prevailing in these countries. Using "true" rates, corrected so as to eliminate the influence of abnormalities in age distribution, there was practically no decline in the fertility of the French people between 1913 and 1930. In spite of moderate declines during the last few years, the fertility of the French has remained about sufficient to supply population replacement indefinitely, and the fertility of the Dutch has remained well above the replacement level. The general drop in the birth rate, which has universally followed industrial and medical advance, got under way first in France. There the movement toward family limitation seems largely to have spent its force, the population is approaching a "normal" age distribution, and there appears to be a strong tendency toward a fairly stationary population. The case of the Netherlands is equally interesting, because the Dutch are largely an urban people and because contraceptive services are reputed to have been most efficiently organized in that country.

It is quite certain that small population decreases will be recorded in many countries during the Twentieth Century, perhaps first of all in England. In some cases this may bring about an advantageous adjustment of population to natural resources. In other cases such diminution in "man power" may lead to vigorous campaigns to increase fertility. But any idea that Europe and the Americas are already on a toboggan slide that reaches to oblivion should be received with great caution. Pessimistic prophets, of course, can always strengthen their position by appealing to the realism of Cassandra, but the citation is inconclusive as Weather Bureau experts can testify.

AN ATTEMPT TO PRODUCE TURKEY-CHICKEN HYBRIDS

D. C. Warren and H. M. Scott
*Kansas Agricultural Experiment Station**

NUMEROUS reports have appeared in the literature describing hybrids between the domestic chicken and the guinea and between the chicken and the pheasant. There have not, however, come to the writers' attention any authentic reports of hybrids between the chicken and the turkey. The naked neck fowl has in some quarters been exploited as a cross between the chicken and the turkey under the name "turken." It is well known, however, that this peculiar condition in the chicken is due to a single dominant genetic factor and that, except for the unfeathered neck, this unusual appearing chicken has no other characteristics which would even suggest turkey parentage.

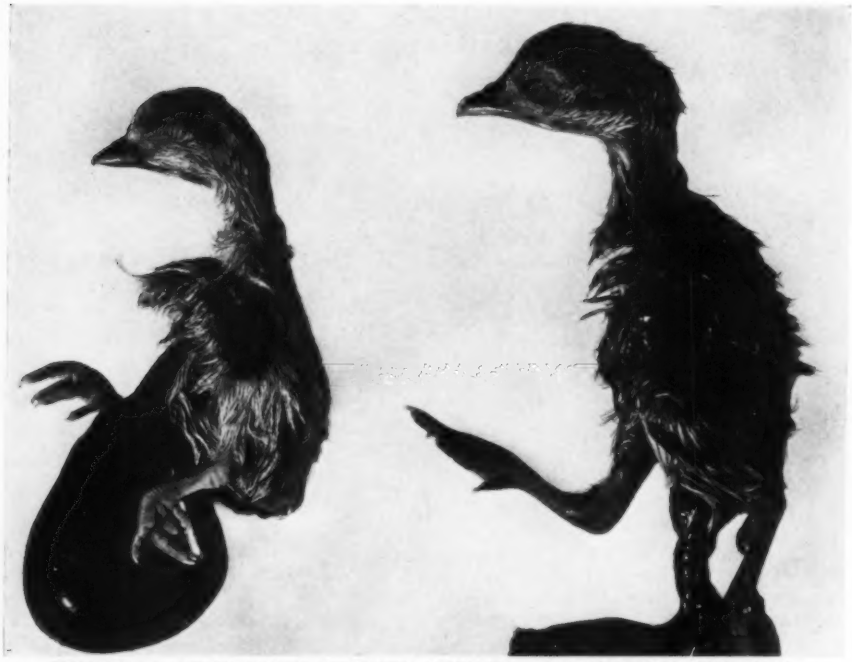
Due to the great difference in size and mating habits of the turkey and the chicken it seems highly improbable that the crossing of these two genera would occur under natural conditions. Therefore, in this experiment artificial insemination was employed in the attempt to cross these two domestic forms. Semen was secured by interposing between the male bird and a decoy female of his own species, a warm watchglass at the time of coition. The chicken semen was immediately transmitted to laying turkey females and the turkey semen to chicken females.

In the earlier experiment the semen was merely released into the female's cloaca by means of a pipette but in the later work it was pipetted directly into the oviduct. This was accomplished by inserting the digit into the oviduct as far as the uterus, then using the digit as a guide, a small calibrated pipette was inserted into the vagina or uterus and the semen released there. It was believed that the opportunity for fertilization would be improved if the sperm were released in this portion of the oviduct rather than in the cloaca.

In the early experiments six laying Rhode Island Red females were inseminated with Bronze turkey semen but no fertile eggs resulted. One laying Bronze turkey female was inseminated with semen from White Leghorn males eight times at approximately two-day intervals but none of the eggs produced was found to be fertile when placed in the incubator.

After a second Bronze turkey female had produced four infertile eggs she was inseminated with semen of a Rhode Island Red male on April 22. The egg produced by this female on April 24 was found to be fertile when broken after a few days of incubation and, although the embryo was dead and largely decomposed, the presence of vitelline circulation was unquestionable evidence of development having started. The egg laid on April 25 was also fertile and the embryo lived during 22 days of incubation (turkey incubation period 28 days). At the time of death the embryo was fully covered with down and had most of the characteristics of a normal turkey except that the down was generally lighter in color, especially about the head and neck. The most conclusive bit of evidence that the embryo was a chicken-turkey hybrid was the stage of development which it had attained at the time of death. The entire yolk stalk had been drawn into the body as well as some of the yolk. This does not occur in the normal turkey embryo until about the twenty-fifth day of incubation. These facts together with the elapse of a 64-day period since the isolation of the female

*Contribution No. 85, the Department of Poultry Husbandry.



EMBRYOS OF TURKEY-CHICKEN HYBRID AND NORMAL TURKEY

Figure 3

Embryos of normal turkey (right) and turkey-chicken hybrid (left). The turkey embryo shows the stage of development after twenty-four days of incubation and the hybrid embryo after twenty-two days of incubation. Each developed in a turkey egg but the hybrid is considerably more advanced than the turkey although it had two days less incubation. Note that the yolk stalk is entirely drawn into the body of the hybrid but that the stalk has considerable length in the turkey. The hybrid also has much lighter down color.

would seem to be sufficient evidence to establish the fact that this was a hybrid embryo.

In the later experiment when the semen was introduced directly into the oviduct a better opportunity for cross fertilization was provided. Six White Leghorn and an equal number of Rhode Island Red females were inseminated with Bronze turkey semen. They had been isolated from males about four months. These females were in production and all eggs produced for a ten-day period were incubated. Fifty-one eggs were produced and only one showed unquestionable evidence of embryonic development. This embryo was abnormal in shape and size but approximated the 72-hour chick stage at the time of death.

Two Bronze turkey females which had been isolated from any males for about four months were inseminated with chicken semen (one by a cross-bred male and the other by a White Leghorn male) a few days after they started to lay in early April. They each produced two or more infertile eggs before insemination. They were inseminated seven times at about two-day intervals. One produced four fertile eggs and the other produced eight. None of the embryos hatched and most of them seemed to have died at a stage comparable to a 60-hour chick or earlier.

These results indicate that it is possible to fertilize both turkey and chicken eggs with sperm of the other. The per-

centages of fertilization were much higher where the turkey female was inseminated with chicken semen. In all cases the embryos died before hatching although one (in turkey egg) lived to the twenty-second day of incubation. Although it seems difficult to produce hybrids which will live and hatch, our results would indicate the possibility of doing so. If such a hybrid were matured, the chances are very much in favor of its being sterile.

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A GUIDEBOOK FOR PATHOLOGICAL HEREDITY

THIS book* is one of a series on medical practice edited by Grote, Fromme, and Warnekros. The author is known outside of Germany for his important contributions to the study of twins as "indicators" of the limits of heredity and environment in molding the individual. The purpose of the book, as stated in the preface, is to provide physicians with a reference which will bridge the gap between actual practice and theoretical, scientific research in the problems of inheritance.

With this in mind the author discusses the increasing responsibility of the practicing physician in a society which has become conscious of the value of its racial inheritance. He points out the dangers which have arisen due to adverse selection, harmful environmental influences, racial mixture, etc.

Following an historical account of the development of the study of inheritance is a summary of the known facts of Mendelism, origin of mutations, phenotypic manifestations of heritable characters, the problem of "Constitution," and lethal factors, inbreeding, racial mixture, and racial pathology. Examples are drawn from a wide range of literature and clinical experience.

Another chapter is devoted to a summary of special pathology of inheritance, including a brief statement of the present knowledge of all those clinical conditions which are, or have been, believed to be of hereditary nature. This section supplies a concise and very valuable reference for any student of medicine. Clinical conditions are considered in organ groups. Where doubt exists as to the nature of the process evolved, statistics are given and references cited, the reader being left to draw his own conclusion. The systems of the body are considered in order of importance from the point of view of heredity. They are grouped as follows:

I. Neurological and mental diseases.
II. Hereditary constitution (diathesis), Internal organs, infection.
III. Anomalies of structure, surgical, orthopedic, gynocological and dental conditions.

In all 252 conditions are mentioned, some being dismissed with a few words, as for instance: "Diabetes insipidus. In many families can be clearly proven to be a simple dominant (Gansslen and Fritz, Just, Weil)." Others receive a much more detailed discussion: Manic depressive pscychosis, schizophrenia, diabetes melletus, tuberculosis, congenital dislocation of hip, cancer — occupying about a page each. No pretense is made that this comprises a complete discussion of these conditions, which would be evidently impossible in a volume of this size. The purpose is rather to supply a readily available reference for the practicing physician. No such summary is known to exist in the English literature.

The closing section is devoted to the application of pathology of inheritance to medicine, especially in relation to the law for the Prevention of the Propagation of Heritable Disease of July 14,

*Verschuer, O. Freiherr von, *Erbpathologie—Ein Lehr buch für Ärzte.* Pages, 188, 32 illustrations. Price, RM 8. Theodor Steinkopff, 1934.

1933. The goal of eugenics in medicine is defined as, "an understanding of the patient, which is not satisfied with his classification as a type, but strives on the basis of experience in inheritance, and from a knowledge of the family [and environment] to evaluate his genetic equipment in order to understand the developmental tendencies in health and in disease." Superficially the concept of the greatest good to the patient, and the eugenic ideal may appear to be in conflict, but the difficulty is overcome, although isolated perplexities may arise, if the physician remembers to regard "man, not as a separate individual, but as a member of an integrated entirety, as a member of a family, of a race, of a nation."

Practical Applications

Out of the administration of the law of July 14, 1933, arises the necessity for definite principles as a foundation of professional opinion and advice as to need of sterilization, fitness for marriage, and determination of paternity by study of inheritance. These principles are based on statistical study of Mendelian inheritance in twins, in families, and in the general population. From such study definite prognosis may be made as to the inheritance of dominants, recessives, sex-linked characters, and, to a certain extent, for polymers. Accordingly individuals seeking marriage may be grouped in three groups: those in which no contra-indication exists; those in which the outcome is in doubt; and those in which there is no possibility of a healthy progeny. The advice given varies with the degree of involvement, from the granting of an unqualified certificate, or the recommendation that the number of children be strictly limited, to the recommendation for sterilization.

Special prognosis for the diseases cited in the law of 1933 is given with the accepted indication for sterilization. These include:

1. Congenital feeblemindedness.
2. Schizophrenia.
3. Manic Depressive psychosis (varying somewhat with ability of the family).
4. Inherited epilepsy.
5. Hungtington's chorea.
6. Hereditary blindness
7. Hereditary deafness.
8. Severe inherited bodily malformation.
9. Severe alcoholism (engrafted upon a psychopathic or asocial personality).

Statistics of heritable diseases and their inaccuracies are discussed. Mortality and morbidity statistics are erroneous because the fundamental condition is often not recorded. Criminal statistics give an unfair picture. The data are frequently recorded by those unfamiliar with medical conditions. Studies from the school and military populations are most valuable. The former should be more used. A summary of the frequency and distribution of the nine conditions listed above is given.

Inherited Diseases Reportable

In order to discover the sources of genetic weakness in the population, the law of Dec. 5, 1933, provides for the collection of required data. Heritable disease is made reportable. A record is kept of every case, including a complete study of the individual and the family. The information is then available to qualified physicians whose duty it is to decide on sterilization procedures, eligibility for marriage, and questions of paternity. It is hoped that statistics thus gathered will also serve as valuable sources of information for scientific study, not only of the "interesting families," which up to the present have claimed undue attention, but of a large, general cross section of the heritably pathological population.

Finally an outline is given of the education which should be provided those in whose hands the administration and study of the problems of "Erbpathologie" will mainly rest, the general practitioner. The course which should be made available to medical students is discussed, for it is the belief of the author that the success of this venture in positive eugenics will rest with the quantitative and qualitative response of each practicing physician to the new duty which has been placed upon him by the State.

HELEN COOK

THE LATERAL FLOWERS OF TWO-ROWED BARLEY

Varying Levels of Fertility Possibly Associated with Plant Vigor

HARRY V. HARLAN and MARY L. MARTINI
*United States Department of Agriculture**

THIS paper presents the results of observations on two-rowed barleys (*Hordeum distichon* L.). The history of the study may aid in orienting the observations. The writers did not start with an investigation of two-rowed barleys, but were carried into the study on a wave of doubt arising from two sources. At least once every ten years the behavior of six-row × two-row crosses is settled. The senior writer assisted in settling it once. For some reason it does not stay settled. There is too little in common in many of the crosses. The phenotypes of one cross may be easily separated into seven or eight classes, while those of another may appear to have only four or five definite groups. True, there has been developed a genetic vocabulary that reconciles such incompatible features, but despite this, all students of barley periodically return to the making of six-row × two-row crosses. The dissatisfaction these activities imply was reenforced in the writers' case by accumulated observations on standard varieties. It was finally decided to make a careful survey of the material already at hand. The two-rowed varieties were selected for the first venture.

Fertility in Lateral Florets

For three years the writers have given intensive study to 408 strains of two-rowed barley other than *deficiens*. The collection consists of barleys from all over the world. In addition to varieties indigenous to a score of countries, many strains are included which originated in breeding nurseries. This study has been particularly directed toward an understanding of the four rows of sterile lateral flowers which form the basis of the two-rowed grouping.

In 1933 the writers found occasional fertile lateral florets in 44 of the 408 varieties (Figure 4). In other words, nearly 11 per cent of the supposedly normal two-rowed barleys exhibited some fertility in the lateral flowers. Fertility was found in varieties from Abyssinia, Egypt, England, Asia Minor, Russia, Persia, Afghanistan, Mesopotamia, Japan, China, and many countries where barley is an introduced crop. Fertile lateral florets were especially plentiful in hybrid varieties. They were much more common among dense-eared barleys than among those with lax spikes.

In 1931 rudimentary lateral kernels were found in the Smyrna variety. The kernels then found were thin non-viable seeds, the growth of which had been arrested not more than four days after flowering. In 1933 the kernels on this and other varieties were well developed, having grown and matured normally.

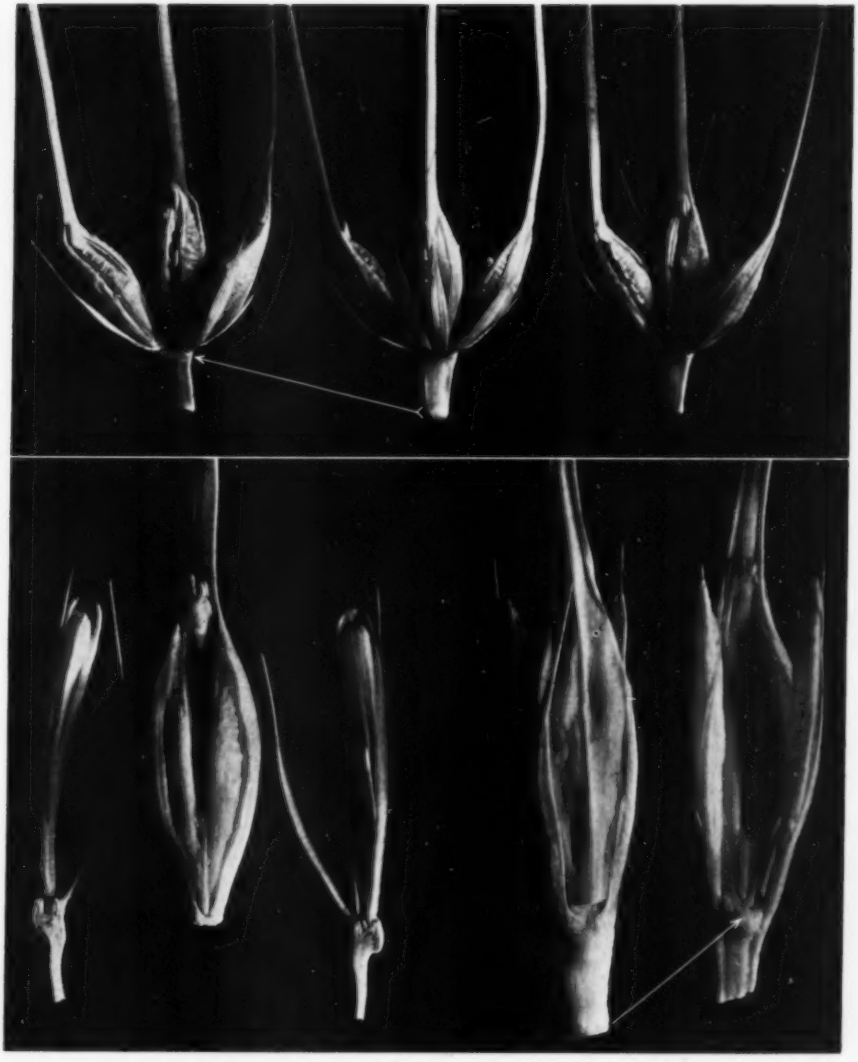
The results obtained in 1933 are probably a near-maximum expression of fertility. Conditions under irrigation in Idaho are always favorable for production of lateral kernels, but in 1933 an unusually large number of varieties produced such kernels. On the other hand, the writers feel sure that the possibility is present in many of the remaining varieties and will be noted in later years. Most of the varieties produced very few lateral kernels.

*These studies were made on the Aberdeen Substation, Aberdeen, Idaho, in connection with cereal experiments conducted cooperatively by the Idaho Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

FERTILE LATERAL KERNELS IN TWO-ROWED BARLEYS

Figure 4

Heads of three strains of two-rowed barley showing supernumerary kernels. Two of these are indicated by the black arrows. There is another one in the head to the left and one close to the tip in the head in the center. Two-rowed barleys vary greatly in the extent of fertility of lateral flowers.



SIX-ROWED AND TWO-ROWED BARLEY COMPARED

Figure 5

Above are three spikelets of six-rowed barley showing the development of the three kernels which make up the spikelet. These spikelets are built up into heads by superposing them one on the other as is indicated by the white arrow. Below are enlarged spikelets of two-rowed barley showing how they are made up of a single developed kernel with the lateral flowers abortive. The remarkable regularity with which the lateral flowers abort in the two-rowed forms is a striking evidence of the regularity of genetically controlled processes. In some crosses of six-rowed × two-rowed forms varying tendencies for the development of the lateral flowers are noted.

These were usually found on secondary spikes much later than the several more vigorous main culms of the plants. They also occurred most frequently on the end plants of the rows. Great care was taken in recording observations to be certain that no adventitious flowers were included. Fertile adventitious flowers are common in barley but are easily identified. Every variety noted in Table I had one or more seeds in perfectly normal lateral flowers at nodes where no extra flowers were present. Indeed, the varieties producing lateral kernels showed less than an average tendency to adventitious flowers. All plants recorded were free from any suspicion of recent hybrid origin and none was heterozygous for observable characters.

In the classification of the material it early became apparent that there were several groups of two-rowed barleys that, by more or less definite steps, bridged directly with the fixed intermedium (*Hordeum intermedium* Koern). There are barleys of the *H. intermedium* group that regularly produce many kernels in the lateral florets. There are members of the same group that produce a few kernels. There are two-rowed varieties, such as the 44 noted above, that may occasionally produce kernels. There are other two-rowed sorts which the writers feel may possibly do so, and others in which they feel certain that their production at any time seems very unlikely.

The different levels of fertility are very evident. They are evident not only in the flowers, but in many cases are correlated with vigor of plant growth that may be significant.

Discussion

A discussion of observations is difficult. Every individual who has spent twenty-five years in the study of a single crop knows that every observation is related to something that has gone before. *Hordeum intermedium* has always raised many questions. The writers have often pointed out that the lemmas of the lateral florets of the typical *H. intermedium* are rounded like those of two-rowed barleys and do not interlock with the palea as they do in the six-rowed forms. Also, they have long suspected that many two-rowed barleys with large lateral flowers belong to the *H. intermedium* group. Two-rowed varieties have been carried for twenty years with an occasional note, "probably sterile *intermedium*." One such, Bolton, an old Canadian hybrid, produced dozens of fertile lateral flowers in 1933. The writers' field records of hybrid classifications are filled with two-rowed segregates labelled "probably *intermedium*." Suspicion of different fertility levels was stated in a previous publication.*

Table I. Varieties of two-rowed barley producing kernels in the lateral flowers at Aberdeen, Idaho, 1933.

C. I. No.*	Name	Source	Awn Emergence	Rachilla	Density
2505	Englawnless	Hybrid (Eng.)	July 2	Long	3.2
2503	"	"	July 1	Long	3.2
967	Jet	Ethiopia	June 19	Short	3.5
2947		Egypt	June 22	Short	2.4
686	Shiratama	Japan	June 29	Long	2.5
2951-2		Ethiopia	June 21	Short	3.1
2429	Comp. cross† selection	Hybrid	June 16	Short	4.9
2467	Ingrescens		July 5	Short	3.6
3417	Comp. cross selection	Hybrid	June 15	Long	2.3
5426	"	"	June 17	Short	3.9
5427	"	"	June 21	Long	3.8
1874		"	June 27	Long	3.7
1915	Beaver	"	July 2	Long	3.1
177	Bolton	"	June 29	Long	3.0
5432	Comp. cross selection	"	June 27	Long	3.0
5437	"	"	June 24	Long	2.9
5413	"	"	June 22	Long	2.7
1389	Zeocriton	England	June 30	Long	2.8
2540	"	"	July 1	Long	1.8
2893	"	"	"	Long	1.7
2270	Pavonimum	Asia	July 3	Long	1.8
2258	Abyssinian	Ethiopia	July 1	Short	3.3
1117	Khayfan	Hybrid	June 29	Short	3.6
2291	Childs	"	July 3	Long	3.8
4203-5		Venezuela	July 12	Long	2.2
4287-8		China	July 11	Long	2.2
2069	Thorpe	England	July 6	Short	2.8
1917	English	Saskatchewan	July 11	Short	2.4
1919	Peacock	Europe	July 9	Long	2.4
740	Canad. Thorpe	Canada	June 28	Long	2.7
4271-1		Manchuria	July 8	Long	2.6
2255		Chico, 1917	July 4	Short	2.5
4731		Manchuria	June 29	Long	2.6
3959		Russia	June 18	Long	3.5
658	White Smyrna (Duchoe)	Asia Minor	June 24	Long	3.6
3469	Smyrna	"	June 19	Long	3.4
2080	White Smyrna	"	June 24	Long	3.6
2555		Persia	June 17	Long	3.8
4189		Afghanistan	June 15	Long	3.6
1466	Estan	Engledow	June 16	Short	2.9
3337		Mesopotamia	June 15	Short	3.0
4366-1		Russia	June 19	Long	4.4
3195	Winter barley	Japan	July 8	Short	2.4
	Orel	Russia	July 12	No data	

* Accession number of the Division of Cereal Crops and Diseases.

† Composite cross involving all combinations of 28 varieties made by the authors.

*Harlan, H. V., and Hayes, H. K. Occurrence of the fixed intermediate *hordeum intermedium haxtoni* in crosses between *H. vulgare pallidum* and *H. distichon palmella*. *Jour. Agr. Research* 19: 575-592, illus. 1920.

The writers have long felt that the entire group of erect two-rowed barleys (*Hordeum distichon palmella erectum*), as well as *H. intermedium* itself was of hybrid origin, preserved because of an agronomic preference. This feeling was strengthened by the facts that became evident in this study. Erect two-rowed varieties are relatively scarce in comparison with the lax forms. They are usually vigorous, as strains selected for farm use would naturally be. The association of the vigor factor is well illustrated in the breeding work at Aberdeen, Idaho. In Table I it will be noted that there are 31 selections from a Composite Cross, most of the hybrids having been made at Aberdeen in 1929. These are the two-rowed segregates which have survived the test of yield. It will be noted that seven of these produced fertile lateral flowers. In other words, the factor that results in fertility of lateral florets is often associated with a plant vigor which results in high yields. The same intangible impression of vigor has probably a place in the unknown history of many of the old two-rowed varieties.

Hybrid populations reveal a parallel series of fertility levels. In some six-rowed × two-rowed crosses the phenotypes are few. In others they are many and distinct. These phenotypes are genetically different. Often, in the same cross, *intermedium* forms of very different character may be found. One may produce many lateral kernels on every spike, while another may produce only an occasional kernel. All too frequently a homozygous strain produces none, but, because of the size of the lateral florets, leaves the observer with a very definite feeling that kernels should have been present. In many such crosses the six-rowed segregates can be separated into at least two groups by inspection alone. It is the intention of the writers to make a careful study of six-rowed forms, and they feel certain that several levels of fertility will be found.

With regard to the possible economic significance of the study, G. A. Wiebe suggests, and the writers agree with the suggestion, that a combination of high-fertility factors may result in a barley of high yield and, in the six-rowed varieties, of greater uniformity than is commonly found.

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Books Received

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

THE PHYSICAL AND MENTAL GROWTH OF PREMATURELY BORN CHILDREN, *by* J. H. HESS, G. J. MOHR, and P. F. BARTELME. Pages, 449. Price, $5.00. The University of Chicago Press, Chicago, 1934.

Detailed studies with elaborate statistical trimmings, of the developmental history of two thousand prematurely born children,—probably more factual data on a rather controversial subject than is to be found anywhere else. Prematurity *per se* is apparently not a matter for alarm.

PRINCIPLES OF GENETICS AND EUGENICS. A Study of Heredity and Variation in Plants, Animals, and Man, *by* NATHAN FASTEN. Pages, 407. 120 illustrations. Price, $2.80. Ginn and Company, Boston, 1935.

PEDIGREES OF HEREDITARY DISEASES AND ABNORMALITIES FOUND IN THE JAPANESE RACE, *by* TAKU KOMAI. Compiled with remarks. 51 pages of text, 84 plates. Kyoto, Japan, 1934.

A most interesting venture in attempting to get under one cover family pedigree charts of all the inherited diseases and deviations from the normal found in the Japanese Race.

HUMAN STERILITY, *by* SAMUEL RAYNOR MEAKER, M. D. Causation, diagnosis, and treatment, a practical manual of clinic procedure. Pages, 276, 27 illustrations. Price, $4.00. The Williams & Wilkens Company, Baltimore, 1934.

INDIVIDUAL PSYCHOLOGY AND SEXUAL DIFFICULTIES, *by* ALFRED ADLER *and* F. G. CROOKSHANK. Pages, 55. Price, 2/ 6. The G. W. Daniel Company, London, 1934.

A series of lectures on the efficacy of the Adlerian psychology in reducing personality conflicts.

HUMAN STERILIZATION TODAY, *by* CORA B. S. HOBSON, T. L. S. Pages, 55. Price, 1 s. Watts & Co., London, 1934.

An excellent brief résumé at a very at a modest price.

RESHAPING AGRICULTURE, *by* O. W. WILCOX. Pages, 157. Price, $2.00. W. W. Norton & Company, Inc., 1934.

Some thoughts on, among other things, what would happen if we really applied to crop production the genetic and agronomic knowledge now in the "literature cited" of technical publications.

HEREDITY MAINLY HUMAN, *by* ELDON MOORE. Pages, 343, 17 illustrations. Price, 15/. Chapman & Hall, Ltd., London, 1934.

Another assay at taking the ordinary garden variety of genetically unsophisticated *homo sapiens* and leading him through the Wonderland of the Genes and their upshot, living organisms.

GENETIK UND TIERZUCHTUNG, *by* C. KRONACHER. Pages, 280, 61 illustrations, bibliography (88 pages). Price, 37.50 marks. Verlag von Gebruder Borntraeger, Berlin, 1934.

When the art of the animal breeder finds itself in 1934, on account of so much research in genetics since 1900. Documented with a hundred-page bibliography.

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The Brahma-Plymouth Rock Mosaic

PROFESSOR Castle in the February, 1935, number of the JOURNAL OF HEREDITY suggests an explanation for the Brahma-plymouth Rock mosaic described by us in the same journal for January.

> If there were two fathers, instead of one, one being a Brahma, the other a Plymouth Rock, the characteristics of the mosaic bird would naturally result. . . A sperm from a Plymouth Rock male, fertilizing the egg, would produce the kind of structures found in the right half of the mosaic bird,—viz., (1) barred feathers, (2) clean leg, (3) medium size of body. A sperm from a Brahma male, fertilizing the egg, would produce the structures found in the left half of the mosaic, viz., (1) Brahma (Columbian) plumage pattern, (2) feathered leg, (3) larger body size.

If double fertilization occurred the two nuclei of the eggs ought to carry the same genes. Using only the ones involved in this mosaic they would be (1) barring—*B*, (2) clean leg—*f*, (3) extension of pigment—*E*, (4) smaller body size. The number and nature of these body size genes is not known.

The Brahma or Columbian pattern is due to a gene for restriction of pigment (*e*) which is recessive to extension (*E*) possessed by the Barred Plymouth Rock. Dunn has reported crosses between Brahmas and Barred Rocks, in which the F_1 individuals had extended pigment.

Therefore, in Professor Castle's explanation he has yet to account for the absence of *E* on the Brahma side of the mosaic. This would mean a double fertilization and a gene loss or inactivation, Because we could not find evidence of double fertilization in birds and even if such evidence were available it would be necessary to invoke some other accessary explanation we discarded the hypothesis of fertilization by two males as being highly improbable.

E. ROBERTS,
J. H. QUISENBERRY.
College of Agriculture, Urbana, Illinois

TWINNING IN THE HEBARD FAMILY

MARY J. BROWN
Zoology Department, University of Wyoming

THE Hebard family (formerly spelled Hibbard) can be traced through six generations, from Robert Hebard, who was born in Salesbury, England, in 1625. The descendants of this family in America totaled over three thousand.

In 1858 George Diah Alonzo Hebard and his family were sent west with a commission from the American Home Missionary Society to Clinton, Iowa to minister to the needs of the people, and later Mrs. George Hebard and her family migrated to Wyoming, where one member still resides from whom this information was obtained. (Dr. Grace Raymond Hebard, Professor of political economy, sociology and Wyoming history).

The writer was interested in twinning in this family because it appeared to be unusually prevalent. The descendants of the Hebards have noted this and one has expressed the opinion that this tendency had been a factor in the elimination of certain branches of the family which have left no descendants. The belief that twins tend to be sterile or of low fertility is widely held, in spite of the absence of genetic and statistical evidence to support the view that human twins are less fertile than their single born sibs. Probably the belief is a carry-over from the experience of cattle breeders, as in bi-sexual twinning in cattle, development of a common fetal blood supply produces profound effects on the sexual development of the twins with resultant sterility. This mechanism does not operate to any extent in man, so far as is known.

According to Greulich, who has made a statistical study on the incidence of human births in twenty-one different countries, covering more than 12,000,000 confinements, the twin percentage varied from 1.59 to 0.4 and the triplet percentage from 0.0185 to 0.004. The total twin and triplet ratios for all the countries were found to be 1:85.1 and 1:$(87.3)^2$ respectively. Similarly Arey states that twins occur once in 85 normal births and triplets once in 7,000.

The Hebard geneology lists 3,530 descendants of the original Robert Hebard who have resided in America in generations II to IX inclusive. On the basis of average twinning percentages cited above there should be about forty pairs of twins in this group. As a matter of fact there have only been thirty-six pairs of twins (Table I). These, However, have not been distributed uniformly through the generations but have occurred in generations I, V, VI, VII, and VIII. In these generations there have been 3,075 individuals which should give an average of thirty-six pairs of twins, which exactly agrees with the observed number for the whole number of generations. The distribution of these is, however, not random so that in the early twin bearing generations, there is a deficiency of twins and in the later generations a marked surplus,—the twin percentages in the twin bearing generations being .094, .08, 1.23, and 1.84. The occurrence of one set of triplets in the eighth generation gives a triplet percentage of .028. While this is much above the average of Greulich's figures, it can hardly be taken to have any statistical significance.

Another interesting point is the sex distribution of the twin pairs, there being over twice as many male-male pairs as female-female pairs. If the "sex unknown" pairs are added to the female-female pairs approximate equality is obtained. This can-

not be the correct explanation, however, because in the seventh and eighth generations when most of the twinning occurred, this preponderance of male pairs was greatest and in these two generations only one pair was of unknown sex.

It is felt that the increasing frequency of twins in the later generations and the peculiar sex distributions are of sufficient interest to merit brief notice. A study of these tendencies in other geneologies might bring forth some extremely interesting information. The two trends strongly suggest that genetic factors may be operating though it is conceded that such an explanation is by no means proven.

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1. Arey, A. B. *Textbook of Embryology.* W. B. Saunders and Co. 1931.

2. Greulich, William Walter. Human Multiple Births. *Eugenical News,* Vol. XV, No. 5, 1930.

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TABLE I—Twins Among the Descendants of Robert Hebard

			Sex				
Generation	*Offspring*	*Twins*	♀♀	♀♂	♂♂	?	%
I	....	1	..	....	1	..	....
V	530	5	..	1	..	4	.094
VI	993	8	2	2	3	1	.08
VII	1,064	13	1	6	5	1	1.23
VIII*	488	9	2	3	4	..	1.84
Total	3,075	36	5	12	13	6	....

*Also in generation VIII there is 1 set of triplets (♀♂♂). The percentage for 3530 offspring = .028.

◆

Conference on Population Studies in Relation to Social Planning

Auspices of The Population Association of America
Hotel Willard, Washington, D. C., May 2-4, 1935

The purpose of this conference is to focus attention on the importance of population studies in public affairs, especially in relation to planning government activities, and to clarify problems on which further research is needed. This will be primarily a conference between research workers in the field of population and persons engaged in administration or teaching in related fields. In order to promote informal discussion, some round tables limited to members of the conference, and others especially invited, are being arranged. All other sessions will be open to the public.

Program

Thursday morning. Meeting with Census officials and exhibit of Census procedures.

Thursday afternoon. Session on public health and vital statistics.

Thursday evening. Association dinner and public session: population studies in relation to social planning.

Friday morning. Session on population distribution.

Friday afternoon. Round table on internal migration and population redistribution.

Friday evening. Session on differential reproduction.

Saturday morning. Round table on the place of population studies in the university curriculum.

The officers of the Association are Henry P. Fairchild, President; Louis I. Dublin, First Vice President; Warren S. Thompson, Second Vice-President; and Frank Lorimer, Secretary. The members of the Program Committee are O. E. Baker of the Department of Agriculture, Chairman; Ellsworth Huntington, Frank W. Notestein, Raymond Pearl, Warren S. Thompson, Leon E. Truesdell, and A. B. Wolfe. Calvert L. Dedrick, of the Central Statistical Board, Watson Davis, and Mrs. R. V. Oulahan are in charge of arrangements. For further information, address the Secretary, 308 Victor Building, Washington, D. C.

SEX, GENES, AND RESTING NUCLEI

Reviews of Books Dealing with Three Aspects of Plant Cell Behavior and Such End Products as Dioecism and Gardens.

*

SEX IN PLANTS

THIS book,* of 193 clearly written pages and 66 apt and easily intelligible diagrams and halftones, is in general very well suited to its evident purpose of appealing to the lay reader and to the young botanist turning to it for an introduction to the subject of sexuality in plants.

There are many interesting references in the book to agricultural practice in fruit and crop growing as influenced by the need of natural or artificial pollination. The summary of the experiments of Yampolsky gives the reader an idea of the way in which certain problems of sex distinction are studied. The discussions of sterility and parthenocarpy and those of hybrid sterility and sex chromosomes are among the many instructive and readily intelligible chapters which should arouse the interest of the layman and of the young botanical student.

A brief list of the more general handbooks dealing with the field covered by this book would surely be helpful to the reader whose interest has been aroused by the excellent brief presentation of the subject given by Robbins and Pearson. The many excellent qualities of this book would, it seems to the reviewer, be definitely enhanced by the correction of certain unfortunate shortcomings several of which may be mentioned here.

The language of the book is always simple enough to be understandable. It is sometimes, however, unnecessarily anthropomorphic. Thus the Pronuba moth is said to "hand pollinate" the flower of the *Yucca* and thus "she makes sure that *Yucca* seed will be growing to feed her larvae when they hatch." This assumes a rather surprising awareness of the fate of her eggs for a moth that has never even laid eggs before. Again in speaking of the penetration of the spermatozoon into the egg, it is said "a chemical *device* has recently been discovered in certain animals which begins *pulling* the sperm right into the egg the minute it touches it."

The unnecessary avoidance of scientific names is sometimes unfortunate and tends to confusion rather than clarity. Thus the name "brown rockweed" does not tell the reader which of several genera of Fucaceae may be intended. The addition of a single word *Ascophyllum*, or *Fucus*, would identify the plant unmistakably.

In speaking of Selaginella as "shrubby Christmas greens" the authors evidently have in mind some California species. No Selaginella of the northeastern United States would fit with this description. It is also hardly necessary for either brevity or clearness to speak of the microsporangia of Selaginella as "sex organs" which are said to "produce numerous small spores which, when shed, grow into male (i. e. sex-bearing) plants." The statement that "In most algae and fungi there is no regular alternation of spore-producing and egg-producing generations" is becoming less true year by year. Mention of the *frequency* of occurrence of such an alternation, in many groups of algae and fungi would be more significantly correct. It seems hardly necessary

*Robbins, Wilfred W., and Helen M. Pearson. *Sex in the Plant World.* Pages, 193. Price, $2.00. D. Appleton-Century Co., New York, 1933.

or correct to assume that the microsporophyll (of angiosperms) has evolved from "male spore-bearing leaves that *folded around* the male-producing spores and became stamens."

In spite of such inaccuracies, many of which are evidently the results of the attempt to make the discussion simpler, this book is far more usable and generally readable than any similar work in this field known to the reviewer.

DUNCAN S. JOHNSON,
Johns Hopkins University.

✣

GENETICS FOR THE HORTICULTURIST

THE appearance of a new book on plant breeding based on modern genetics is likely to interest a large number of students in this applied science. While Dr. Kappert's new book* is addressed particularly to the breeder of horticultural plants, it is obviously intended also for students with a major in horticulture. To the English speaking student this book may be of interest largely from the viewpoint of his readings in simple scientific German.

By virtue of his natural inclination to scientific procedure, his broad practical background and his general interest in the application of genetics to plant breeding, the author chooses to limit the subject matter largely to a comprehensive survey of the basic principles of genetics insofar as they apply to practical problems.

After a general consideration of Mendel's laws of inheritance and the varied phenomena due to the interaction of factors, discussion is devoted to the statistical consequences of Mendelian heredity relative to the composition of populations in successive generations of self fertilization and random mating. A brief exposition of the effects of continued mass selection and of individual selection before and after flowering in self fertilized and cross fertilized species follows.

There is an instructive discussion of chance variations from Mendelian ratios and the usual methods of calculating statistical constants for a normal distribution. The use of probable error formulae is adopted for tests of significance of Mendelian ratios. Two sections deal with abnormal segregation ratios as the result of zygotic and gametic lethals. A selected number of examples from the literature serves to illustrate the inheritance of double flowering and of heterostyly, and the mechanism of sex determinations in dioecious plants.

Other sections sum up the known facts regarding mitosis and meiosis, the time during which gene segregation takes place in gametogenesis and the chromosome theory of heredity. The sections dealing with sex linkage, linkage and crossing over, pleiotropism and multiple allelomorphism are very typical of the book on the whole. In this connection, for instance, considerable space is devoted to a consideration of the applied aspects of linkage and crossing over. Using Mathiola as an illustration, detailed directions are given in two instances for developing new color varieties by means of various crosses in which incomplete linkage and gametic sterility are complicating factors. Unfortunately several minor errors creep in to cause some confusion in the set-up.

The phenomena of non-disjunction, polyploidy, heteroploidy, chromosome translocations, ring formation of chromosomes, balanced lethals and cytoplas-

*KAPPERT, H., *Grundrisz der Gaertnerischen Pflanzenzuechtung.* Paul Parey, Berlin, 1934.

mic inheritance are reviewed with material from the literature. Two sections are given to a discussion on modifying effects of the environment in relation to heredity in development, the origin and nature of mutations and chimeras. Practical problems in hybridization and selection, selection in pure lines and clones, experimental methods in performance tests, inbreeding and hybrid vigor are among the items discussed in the concluding sections.

In general, the book gives an interesting and valuable account of the subject. Certain sections, particularly those dealing with inbreeding, hybrid vigor, size inheritance and disease resistance are much more sketchy than their general importance warrants. To a reader who is seeking to acquire a working knowledge of genetics, the book can be heartily recommended.

H. O. Hetzer
Iowa State College

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CYTOLOGY OF THE RESTING NUCLEUS

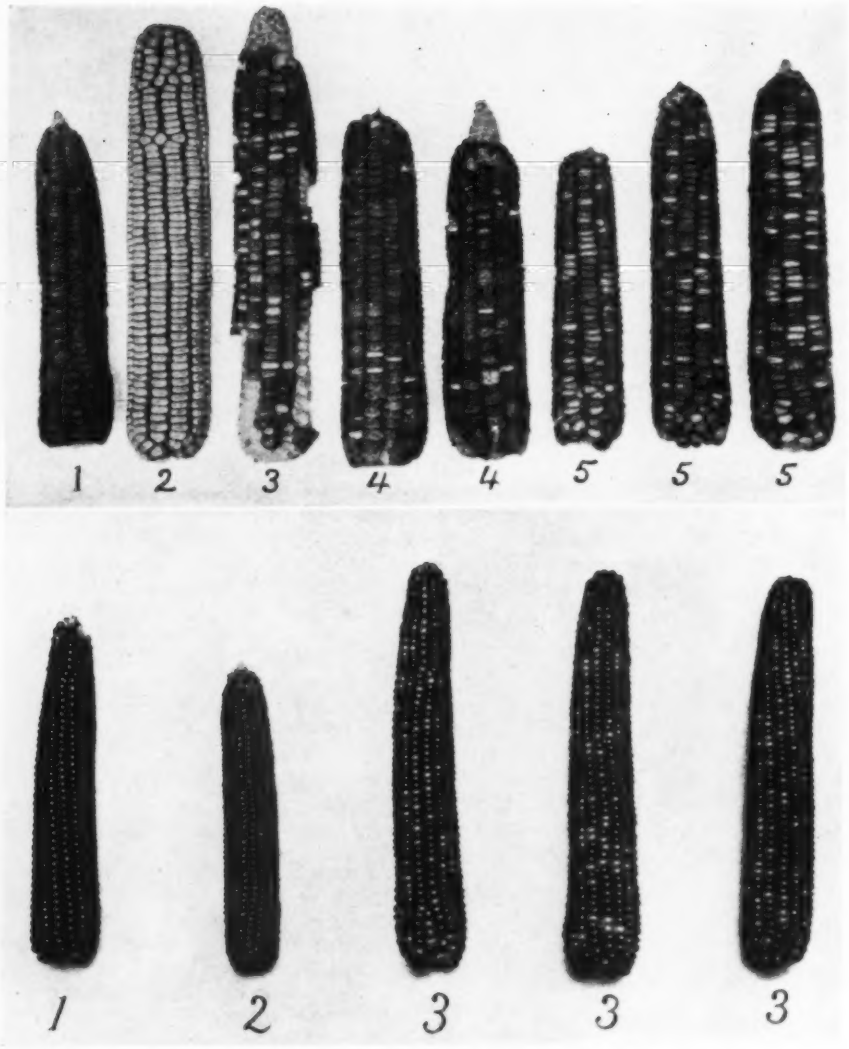
THIS is a well organized compilation of facts and theories dealing with the resting nucleus in plants,* though a cyto-geneticist may be surprised by the scarcity of references to the chromatin.

The first of the twelve chapters is devoted to a general consideration of the resting nucleus including special forms, size, and growth. The second chapter deals with the chemical organization of the resting nucleus. Consideration is given to vital staining, Feulgen's nucleal reaction, basic and acid dyes as well as to nuclear lipoids, enzymes and salts. The third chapter treats of the morphological structure of the ground substance and the karyolymph as revealed by various means including the ultra-microscope. The fourth chapter takes up the morphology of nucleoli, their presence and absence, form, structure, "Hofbildung" and finally their significance. The fifth chapter deals with the protein crystals of the nucleus, their structure and their ecological significance in plant cells. Chapter six is devoted to the nuclear membrane; its origin and its importance in cellular physiology. The seventh chapter concerns the interchange of material between nucleus and cytoplasm. Energy, secretion, excretion, symbiosis, disease, chromatin elimination, enucleated cells and isolated nuclei in nutrient media are among the subjects discussed. Chapter eight takes up the relation of the nucleus to plastids, chondriosomes, centrosomes and blepharoplasts. Chapter nine deals with the relation of the resting nucleus to cell wall formation and with movements of the nucleus within the cell. Chapter ten treats of the relation of the resting nucleus to different types of cell division with very little reference to the behavior of the chromatin. Chapter eleven is devoted to multinucleate cells; their normal occurrence and methods of experimental production, also secondary syncytial formation by solution of cell walls. The last chapter deals with degeneration and resorption of resting nuclei.

An excellent bibliography of 129 pages is a very useful feature as are also author, subject and systematic indices. This book should be available as a reference for cytologists, be they zoologists or botanists.

E. Eleanor Carothers
Dept. of Zool., Univ. of Penna.

*Tischler, Georg. *Allgemeine Pflanzenkaryologia.* 1 Halfte: "Der Ruhekern." Zweite Auflage. Price 76.80 RM. Gebruder Borntraeger.



McCLUER'S MAIZE CROSSES

Figure 6

Above are reproduced two of McCluer's illustrations, originally published in Bulletin 21 of the Illinois Experiment Station for 1892. The upper row shows ears of the two parental strains [Black Mexican (*1*) and white dent (*2*)], the F_1 (*3*), and five ears (*4-5*) produced by seeds from this ear. The two *4*'s are from plants grown from sugary seeds, and the three *5*'s, from starchy seeds. The lower illustration shows a cross between yellow (*1*) and white (*2*) pop corn. The three F_1 ears (*3*) show considerable heterosis.

EARLY RESEARCHES IN MAIZE GENETICS

W. RALPH SINGLETON

(Concluded from the February Number)

WHEN considering the researches of the early investigators of corn genetics, the work of George W. McCluer[24] at the Illinois Experiment Station, Champaign, Illinois, seems to us outstanding. Had he possessed just a little more curiosity, or perhaps a greater interest in mathematics, it is quite possible he would have obtained all the facts of Mendel's Law. But he was a practical man and was working with many other things besides corn, so possibly he did not have time to devote to analysis of corn hybrids. In 1889, McCluer produced sixteen ears by crossing different varieties of dent corn. In 1890, 158 ears were produced by crosses between different varieties, or by crossing different stalks within the same variety, or by self-fertilization. Also various combinations of dent, sweet, flint, pop, and flour corn were made in both years. Excerpts from McCluer's bulletin will be quoted to show how nearly his conclusions agree with ours today.

Ears produced by crossing white sweet corn with pollen of yellow dent corn have been nearly as dark as the male variety, with kernels very much like flint in appearance, neither dent nor wrinkled, and with the taste characteristic of dent corn. The kernels are probably increased in size, at least the seed coat is not shriveled as is characteristic of sweet corn.

He weighed one hundred kernels of sweet and dent taken from five different ears segregating for *Su su* and found the *Su* kernels averaged 34.6 grams in comparison with 27.9 for the sweet kernels.

The next observation is significant. McCluer was the first of the American corn investigators to distinguish the two types of color, pericarp and aleurone. Körnicke had recognized the two kinds of color in 1872. McCluer's observations were probably made without knowledge of Körnicke's work.

Color, where it is a character of the kernel and not of the seed coat, tends very strongly to pass from one variety to another. The peculiar color of the cranberry did not seem to affect the other white varieties to which the pollen was applied. The cranberry owes its color to the seed coat entirely; the kernel is white, and the variety is classed as a white corn. In the white, yellow, and black varieties, and in crosses of these which run into other colors, the color is determined by the kernel and not by the seed coat.

How simple an observation this is, so briefly stated and yet how pertinent!

Ears produced by crossing a white dent with pollen of black Mexican had kernels varying in color from white to black. More than half the kernels were wrinkled and had the taste characteristic of sweet corn. . . .

Here he must have had a heterozygous *Su su* ear pollinated by *su* pollen and obtained "more than half" sweet kernels. Fifty per cent was the expected number. The white kernels on the ear must have been from foreign pollen. Other observations were:

Ears produced by crossing white sweet corn with pollen of yellow sweet corn were nearly as yellow as the pollen-bearing variety.

Ears produced by crossing white dent with pollen of Queen's golden pop corn were nearly as dark as the pollen-bearing parent, and were less dented than is characteristic of the variety. The smoothness may or may not have been an effect of crossing.

Ears produced by crossing Queen's golden pop corn with pollen of white dent seemed lighter in color but were otherwise unchanged. Though the kernels of the dent corn weigh nearly two and one-half times as much as the pop corn the pollen of the dent corn seemed to make no difference in the size of pop corn kernels.

Ears produced by crossing the white pop corn, common pearl, with pollen of Queen's golden were very strongly marked with the yellow color of the male parent. . . .

Of 19 ears produced by these various crosses there were found only two kernels which did not show distinctly the effects of the pollen, and these two kernels were pretty certainly not fertilized with the pollen intended. In the case of sweet corn stalks bearing two ears, where one was crossed and the other left to be naturally fertilized, there was no indication of anything but sweet corn pollen on the naturally fertilized ears.

Such a low percentage of contamination speaks well for the technique of McCluer. He noted that the plots of crossed corn were all as uniform, or even more uniform than pure varieties.

Some of McCluer's crosses are illustrated with excellent photographs. Two of these are reproduced here, through the courtesy of the Illinois Experiment Station. Figure 6 shows a cross between sweet and starchy. The immediate result of pollination is not shown, but we have the parents, the F_1 ear and four different F_2 ears produced by planting starchy and sweet kernels respectively. Figure 6 also shows a cross between white and yellow pop corn. Considerable heterosis is manifest in the F_1 ears. They are segregating for yellow and white, as can be clearly seen from the illustration.

His third figure (5) showed the two parents, the crossed ear, and three F_1 ears of a sweet-starchy hybrid.

Here was excellent material to establish Mendel's Law for two characters, yellow-white and sweet-starchy. Although McCluer made excellent general observations on hybridization, he failed to count any ratios of segregating kernels and so "missed the boat" just as surely as Kellerman and Swingle, Hays, and others.

McCluer noticed that corn grown a second year from the crosses is smaller than that grown the first year. He showed in a table a comparison of weights of ten ears of the parents, F_1 hybrid, and ten F_2 ears. The F_2 ears were not grown from selfed seed, but each plot was from one ear and consequently there was some inbreeding.

The loss of size may be due to a diminution in some way of the vigor imparted by crossing. Each plot being planted from a single ear, there would necessarily be close inbreeding, which it is generally admitted tends to deterioration.

In almost all cases the ten ears from the F_2 plots weighed less than ten similar F_1 ears.

The table giving the weight of 10 selected ears of corn from self-fertilized seed and of ten ears from crossed or from selected seed does not give a correct idea of the inferiority of the corn from self-fertilized seed because it does not take into account either the greater proportion of abortive stalks or of small and poorly filled ears (of the F_2 plot).

GEORGE W. McCLUER
Figure 7

Published in 1892 excellent illustrations of maize hybrids produced by controlled pollination. Noted that the best looking ear does not necessarily produce the best progeny.

McCluer's summary is quoted in full.

The ear of corn may be as readily fertilized by pollen from its own stalk as by the pollen of another stalk. A stalk grown by itself fails to make a perfect ear only because the wind carries the pollen away.

The classes of corn, as dent, sweet, pop, and flour, can be intercrossed with perfect freedom. Corn cannot be improved by self-fertilization.

There seems to be a strong tendency in the progeny of the crosses of the different classes of corn, dent, sweet, and pop toward corn of the flint type.

The results from planting different ears of the same cross are apt to be quite different, and what *appears to be the best ear does not give the best results.* The three ears produced by crossing Mammoth with Leaming were all fertilized by the same pollen. The three ears planted separately produced lots of

*Italics ours.

corn differing from each other fully as much as many of our well-marked varieties. One of the three ears produced by crossing was decidedly superior in size and appearance to the other two, yet one of the inferior ears produced the largest and best corn.*

All of McCluer's observations have been confirmed today. He might be surprised to see the hybrid corns in use today, that are all the product of self-fertilization *and crossing*. His observation that the best ear does not always give the best yield of corn is quite familiar to all today, but it must have sounded like heresy back in 1892. Everyone was taught to select the biggest and best ears, which naturally were expected to give the best yields. On the whole, this is probably true, but it is not so in all cases.

Although McCluer gave us no specific laws of heredity, he should be recognized for his general observations, for they were largely accurate.

Morrow and Gardner[25] also working at the Illinois Experiment Station, made several crosses between different varieties of corn and tested the yield of plots planted with crossed seed in comparison with the parent varieties. They found that in every case the yield of the cross was greater than the average of the parent varieties, the average increase from the five crosses being 9.5 bushels to the acre. They suggested that farmers produce their own crossed seed by planting two varieties in alternate rows and detasseling one of them, and saving seed from the detasseled row only.

Also, in 1894, these investigators[26] reported an experiment to test the yield of self-fertilized ears from a plot of crossed corn in comparison with sib-pollinated seed. They grew three plots from selfed ears and three from the sib-pollinated ears. Their results were:

In every instance the cross-fertilized ear produced the larger yield, and the stalks were visibly larger. Naturally the corn from the self-fertilized ears was more uniform in character than that from the cross-fertilized ones. The greater the difference of the parent varieties, the more variable the product. It is thought that after years of careful selection after crossing, corn fairly uniform can be produced.

Morrow and Gardner also gave the results of four plots of cross-bred corn in comparison with the parent varieties. In three out of four cases the yield of the cross was greater than an average of the parent varieties, the average increase being 2.3 bushels an acre in favor of the crosses. The average for the three plots where the crosses exceeded was 6.1 bushels an acre. One cross was decidedly inferior to the average of the parent varieties. It yielded 9.6 bushels an acre less than the average of the parents.

It is interesting to note that one of the crosses between varieties, Leaming × Burr White, was a cross of the same two varieties used in the first commercial hybrid produced by inbreeding and crossing. That hybrid is Donald F. Jones' Double-Crossed Burr-Leaming (Jones[16]). This cross was produced from two inbreds out of Leaming and two from Burr White. The present Burr-Leaming is a cross between two multiple varieties (made by interpollinating several inbreds from each of the varieties of Burr White and Leaming).

The experiment of Morrow and Gardner was repeated by Gardner[11] in 1894. He found that in four of six cases the yield was greater in the cross, the average being twelve bushels per acre.

Webber[34] made several crosses of a white seeded Hickory King with a purple Cuzco. This work was conducted either at the Nebraska Experiment Station or at Washington, D. C. In most cases there was no color or xenia. On a few kernels he found a few spots of color. Apparently Hickory King carries the inhibitor factor, *I*, which suppresses all color. Occasionally through chromosomal deletion or nondisjunction small patches of color are formed.

He made other crosses, some showing xenia and some not. A cross between Leaming female, and Hickory King male showed no xenia. The plants grown from the crossed seed

showed intermediate characters proving they were hybrids. Webber states, however, that they all had white cobs like the male parent. This certainly is contrary to the way this character behaves today. We know of no dominant white cob. Xenia was observed when white corn was crossed with yellow. Also the effect of the pollen was noticed when Stowell's Evergreen was pollinated by Black Mexican. He obtained xenia when sweet corn was crossed with field corn. He likewise thought he obtained xenia when an ear of Gilman Flint was pollinated by Black Mexican. An illustration is given to illustrate this point. An ear of Gilman Flint pollinated by Black Mexican shows a considerable number of sweet kernels. Webber thought these were the immediate effect of the sweet pollen. What he had was an ear that was segregating *Su su* pollinated by *su* pollen. Naturally some of the kernels were sweet.

Another of Webber's observations which we challenge is his statement that pollen retains its vitality for two weeks. We have conclusive tests to show that corn pollen kept under normal atmospheric conditions loses vitality very fast. At the end of 24 hours, a satisfactory pollination cannot be made with corn pollen. There are still some grains surviving but not enough to obtain well-filled ears although an abundance of pollen is applied. Thirty-six hours seems to be the outside limit for the viability of corn pollen.

The work of Hopkins[15] at the Illinois Experiment Station deserves mention here. He made no crosses, but carried on an intensive selection program in Burr White corn. He found that it is possible to influence the composition of corn; that by proper selection of seed any of its principal constituents, protein, fat, or carbohydrates may be increased or decreased.

In six tests the selection of seed corn of high and low protein content has produced differences in the crops varying from .50 to 1.25 per cent of protein. The selection of seed of high and low fat content produced differences in the crops varying from .67 to 1.45 per cent of fat. And as the percentage of carbohydrates, principally starch in corn, is inversely proportional to the combined percentages of fat and protein, the percentage of starch in corn can likewise be changed by selection.

Hopkins observed that the protein content varied chiefly with the proportion of glutenous layer and the different amounts of this glutenous layer could be observed with the naked eye. Thus it was possible to gauge roughly the protein content of kernels by mechanical examination. It was possible to determine roughly the fat content of corn kernels without a chemical analysis. The amount of fat varies proportionately to the size of the germ, so that the larger the germ the higher the percentage of fat.

This work of Hopkins has another interesting aspect historically. It was while trying to change the fat and protein content of corn that Edward M. East, Hopkins' assistant, began selfing corn in order to obtain pure lines of high and low fat, and high and low protein. He found they decreased in vigor very rapidly. The inbred lines when crossed produced an F_1 hybrid more vigorous than either parent (East[9]). The published report of this work was just a little after Shull's classic paper "The Composition of a Field of Maize" (Shull[28]). The researches of Shull and East were conducted separately and both men came to the same general conclusions. Shull[29, 30] carried the idea a little farther and proposed a definite plan of breeding whereby crossed first generation seed of inbreds could be utilized for crop production.

So we see that up to the time when Mendelian segregation was established in maize by the excellent researches of De Vries[33] and Correns[5] we have a wealth of observations and experiments on the corn plant. Some of these were quite accurate, others were hastily made.

Even the best of the workers did not go far enough to establish any definite

laws about the heredity of maize.

We wish to point out here that De Vries should have priority in establishing a Mendelian segregation in maize, his work being published a year before Correns' work on maize.

By way of summary we give a chronological list of the investigations on maize, up to the time of the rediscovery of Mendel's laws.*

Chronological List of Early Maize Investigations

1694 Camerarius proved that pollen of maize is necessary to fertilize the ovules. (Roberts[27])

1716 Cotton Mather reported wind-pollination, cross-pollination, and immediate effect of pollen on cross-fertilized seeds. (Zirkle[35])

1724 Dudley described variety crosses and wind-pollination of *Zea mays*. (Zirkle[35])

1735 Logan showed by controlled experiments that pollen is necessary for seed formation in *Zea mays*. (Zirkle[35])

1749 Benj. Cooke observed natural crossing in corn when different varieties were planted near each other. (Zirkle[35])

1825 Gärtner made a cross between yellow and striped (variegated pericarp) maize. Concluded pollen has no immediate effect. Grew several hybrids but did not practice close pollination. (Roberts[27])

1845 Lecoq crossed pop corn with dent corn and obtained an intermediate F_1 hybrid. (Roberts[27])

1867 Vilmorin carried out an experiment to test effect of foreign pollen on ears. Concluded pollen often but not always shows effect. (Webber[34])

1868 Hildebrand pollinated two ears of yellow with pollen of dirty brown race. Concluded pollen exercised a direct effect. (Brown color was in pericarp. Effect noticed was due to aleurone color also present in brown corn.)

1872 Körnicke pollinated yellow corn with pollen of reddish-black maize (color in pericarp and aleurone). Yellow and reddish-yellow kernels were produced. (Webber[34])

1876 Beal delivered address stressing pollen selection as well as seed selection.

1878 Beal in talk told of a hybrid between an 8-rowed dent and a flint. First generation showed all gradations between both parents.

1880 Beal told in an address before the Farmers' Institute of an experiment to test the effect of pollen the first year. In every case he got an immediate effect. Beal outlined first experiment to increase yield of corn by crossing.

1881 Focke used term xenia to denote immediate influence of pollen. Found xenia when yellow or white corn was pollinated by a blue variety.

1882 Lazenby grew corn in alternate rows, detasseled one to determine immediate effect of the pollen. Concluded no effect in most cases.

1883 First linkage observed. Sturtevant found that in ears of pod corn, tunicate, there were no sweet kernels while in the normal ears, there were plenty of *su* kernels. (The *Tu Su* ear had apparently been crossed by *tu su* two years previously.)

1884 Sturtevant formulated ten propositions regarding corn breeding. Some of these are true, others have been shown to be false.

1888 Kellerman and Swingle made numerous corn crosses.

1889 Hays made controlled pollinations of maize. Made a drawing of an ear segregating for several color factors as well as *Su su*. An approximate 3:1 ratio of *Su* to *su* can be counted from this drawing.

1889 Kellerman and Swingle made 188 new crosses and grew F_2 generations of previous hybrids. They made no counts but some of their estimates approximated a 3:1 ratio for characters such as yellow-white, and starchy-sugary.

1890 Kellerman and Swingle continued crossing program of previous year.

1890 Crozier and Rolfs observed immediate effect of pollen when seven different varieties were pollinated by Leaming and an early white dent.

1891 Kellerman and Thompson made first count of a segregating ear of maize. Good genetic ratios were obtained for *Pr-pr*, *Y-y*, and one of the color factors probably *C-c* or *R-r*.

1892 McCluer made excellent general observations on corn pollination, immediate effect of pollen, and vigor in F_1 hybrids. His experiments were confined mainly to the first generation.

1893 Morrow and Gardner made several crosses to test yield of crosses in comparison with parent varieties. In most of the cases the F_1 hybrids outyielded the parent varieties.

1899 Hopkins by selection isolated high and low protein strains of corn, also high and low fat.

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*We wish to express our thanks to the following, for permission to reproduce portraits of early maize investigators; to William L. Slate for a photograph of William James Beal; to the New York Experiment Station for the photograph of E. Lewis Sturtevant; to the Minnesota Experiment Station for the photograph of Willet M. Hays; and to the Illinois Experiment Station for the photograph of George W. McCluer.

1900 Webber made several pollinations to test xenia. Some of the crosses which showed immediate effect of the pollen were white × black, sweet × starchy, and white × yellow. No xenia was found in crosses of yellow × white. He thought he obtained xenia when an ear of flint pollinated by Black Mexican produced some sweet kernels. The ear of flint must have been segregating.

1900 De Vries found starchy dominant to sweet and the F_1 ear produced 25 per cent of sweet kernels. Corn was only one of the many plants investigated by De Vries in his excellent researches in which Mendel's law was corroborated.

1901 Correns described inheritance of several seed characters in maize, one of which was the starchy-sweet character. His work confirmed that of De Vries.

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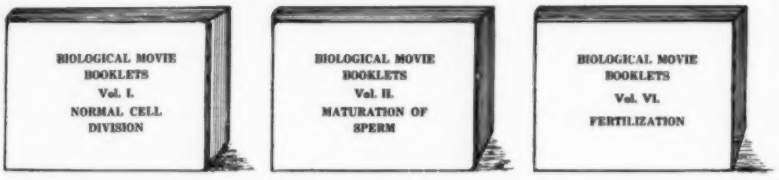

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